

Langmuir Films of Organic Molecules on Mercury

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Beamline(s): X22B

Langmuir films of organic molecules on the surface of mercury were studied systematically for over 40 years[1]. However, all of these studies employed surface tension measurements. Only a single x-ray study of such a monolayer was published to date[2]. Even that recent study deals with thiols on mercury, where the interaction between the molecular head group and the mercury is so strong that the molecule self-assemble into a closely packed layer of surface-normal molecules, and do not exhibit surface pressure dependent structural variation, the most basic characteristic of all Langmuir films. We report here for the first time combined measurements of surface pressure, x-ray reflectivity (XR) and grazing incidence diffraction (GID) for a Langmuir film on the surface of mercury. We employed a Langmuir trough, mounted on the liquid x-ray reflectometer at X22B, which allows simultaneous x-ray and surface tension measurements.

Fig.1 shows XR measurements of stearic acid on mercury at different coverages, along with their fits to molecular-level models of the films' structure. The reflectivity of the pure mercury substrate can be fitted by an oscillatory surface electron density (black), as found earlier[3]. The XR of the film-covered surfaces reveal a monolayer of stearic acid molecules lying flat on the mercury surface at low coverage, $114 \text{ \AA}^2/\text{molecule}$, (blue), a bilayer of lying-down molecules at $50 \text{ \AA}^2/\text{molecule}$ (red), a coexistence of 62% of the molecules aligned normal to the surface with 38% of the molecules lying down as a bilayer at $26 \text{ \AA}^2/\text{molecule}$ (green), and a full monolayer of close-packed surface-normal molecules at a coverage of $19 \text{ \AA}^2/\text{molecule}$ (lilac). GID measurements reveal a single sharp diffraction peak at the highest coverage, indicating the existence of an in-plane hexagonal order of a coherence length of at least a few hundred \AA . A full analysis of the surface-normal and in-plane structure, and its relation to the surface pressure and area/molecule is currently underway.

References:

- [1] T. Smith, *Advan. Coll. Interfac. Sci.* **3**, 162 (1972); A. H. Ellison, *J. Phys. Chem.* **66**, 1867 (1962).
- [2] O.M. Magnussen *et al.*, *Nature* **384**, 250 (1996).
- [3] O.M. Magnussen *et al.*, *Phys. Rev. Let.* **74**, 4444 (1995).

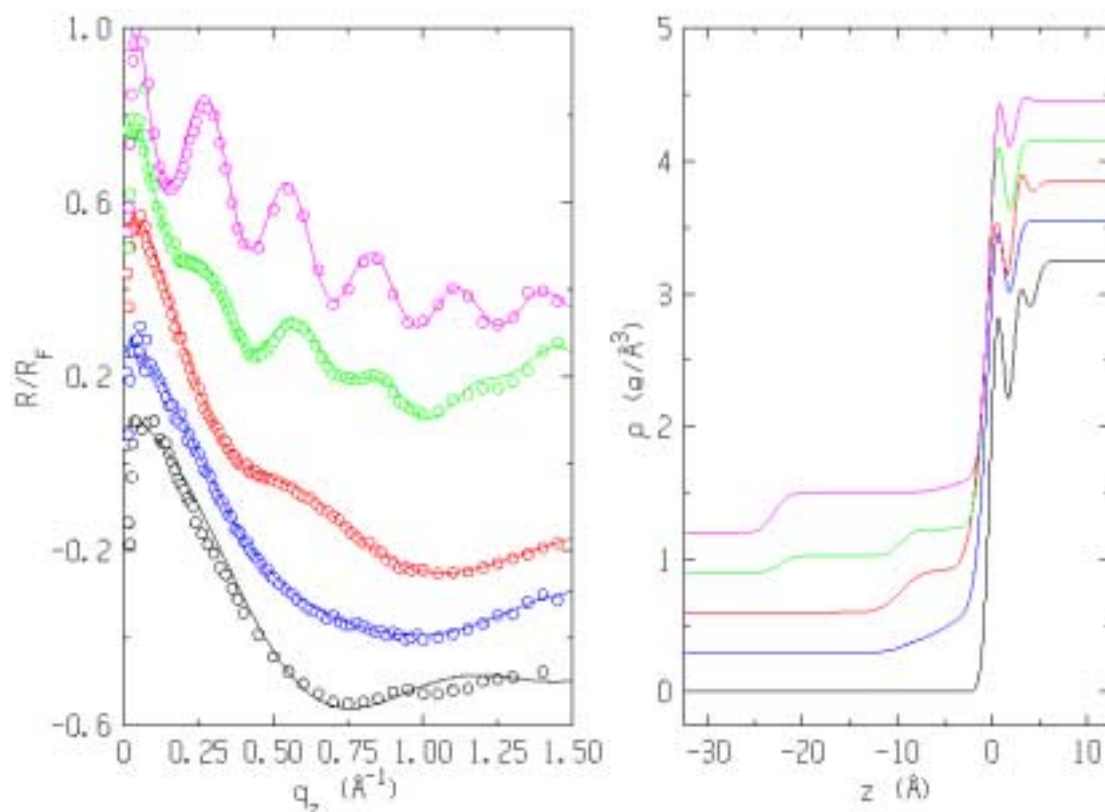


Fig. 1: **Left:** measured, Fresnel-normalized, x-ray reflectivities (points) of a Langmuir film of stearic acid on mercury at different coverages, with model fits (lines). **Right:** the surface-normal electron density profiles corresponding to the model fits. For details and discussion see text.